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APPLICATION OF HORSE GRAM FLOUR IN EXTRUDED PRODUCTS

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ABSTRACT

The horse gram commonly known as kulith is a traditional unexploited tropical grain legume and well known for its hardiness, adaptability to poor soil and adverse climatic condition. The horse gram is a cheapest source of protein. Further it is also rich in minerals such as calcium. The present work is undertaken with a view to add value addition of horse gram by incorporating it in the extruded products using horse gram, maize and rice as an ingredient. The levels of horse gram varied from40,30 and 20 percent ,keeping Maize constant at 50 percent and rice as supporting as 10 ,20,and 30percent respectively. Twin screw Extruder is used for preparation of extrudates from horse gram at 275 rpm,150 ^{0}C and 3mm die. The functional properties viz. Expansion Ratio (ER), Bulk Density (BD), colour and hardness of extrudates were determined. The effect of processing parameters on functional properties was also studied.Expansion ratio, bulk density, colour and hardness were influenced by variations in flour composition. It is found that, extrudate made using horsegram, maize: rice: The findings of investigation study demonstrate the feasibility of developing value added products from horsegram based composite flour by extrusion processing. It is concluded from this study that horsegram extrudates of 20 percent horsegram with 50 percent maize, and 30 percent rice showed better functional properties as compared to all other treatments in terms of high expansion ratio and lightness in colour and lower in hardness.

INTRODUCTION

India grows a variety of pulse crops under a wide range of agro climatic conditions and has a pride of being world largest producer of pulse. Major pulse grown in country is chickpea, pigeon pea, mung bean, lentils, horsegram, field pea, moth gram. Indian population relies on pulses for meeting in protein requirement mainly because of vegetarian food habits and cost of animal based proteins. India produces about 13.18 million tones of pulses from 22.47 million hectare from 71.8 million hectare area. The major pulse producing state of country are Madhya Pradesh, Rajasthan, Uttar Pradesh and Andhra Pradesh which together accounts for 74% of the total production of country. Horse gram (Macrotylomauniflorum, Fabaceac) is one of the important minor pulses grown in India. Horse gram provides nutritious fodder for animals in addition to grain and refers as dual purpose crop. In local languages it is known as kulith, kulath, kulthi ghat depending on state or region. Horse gram is one of the important grain crop of konkan region of Maharashtra state. The area under cultivation during 2007-08 was reported to be 2966.6 ha. and yield was about 7833.3 tones (Anonymous 2, 2012).

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It is usually swon in months of October and November of rabbi seasons after harvesting of paddy. This is done without any intercultural operation. Thus moisture available in soil is used for growth of horse gram which matures in 90 days and can be harvested and hence it is important crop taken by konkan farmers to make use of lateritic soils.The horse gram (Macrotylomauniflorum, Fabaceac) commonly known as kulith is a traditional unexploited tropical grain legume and well known for its hardiness, adaptability to poor soil and adverse climatic condition.

The horse gram is a cheapest source of protein. Further it is also rich in minerals such as calcium. The chemical composition is comparable with commonly cultivated legumes. Like the other legumes, this is deficient in methionine and tryptophan. Horse gram is excellent source of iron and molybdenum. Comparatively horse gram seeds have higher trypsin inhibitor and hem agglutinin activities and poly phenols than moth bean seeds. Dehusking germination is a simple method of food processing that increase nutritive values and decrease phytate, tannin level and increase the availability of iron and calcium (Anonymous 1, 2012). Extrusion cooking is one of the most efficient and versatile food processing technologies that can be used to produce pre-cooked and dehydrated foods which will break down the

starch and denature protein, thereby improve digestibility. Extrusion combine the effect of heat with the act of extrusion and is an energy-efficient industrial process used widely in the production of blended foods, which is a much more controlled process than roasting and only takes 30-60 second. These processes involved conveying, mixing, and compressing of moist materials to form dough that could be extruded as simple rods, or in the case of pasta, as well-defined shapes. (Camire, 1991).The present work is undertaken with a view to add value addition of horse gram by incorporating it in the extruded products and thereby attempt solving the malnutrition problem through horse gram, maize and rice as an ingredient..

REVIEW OF LITERATURE

Extrusion Cooking Technology

Eastman *et al*. (2001). Extrusion can be defined as the process of forcing a pumpable material through a restricted opening. It involves compressing and working a material to form a semisolid mass under a variety of controlled conditions and then forcing it, at a predetermined rate to pass through a hole. The origins of extrusion are in the metallurgical industry, where in 1797 a piston driven device was used to produce seamless lead pipes. In the 1930s, a single-screw extruder was introduced to the pasta industry, to both mix the ingredients (semolina and water) and to shape the resulting dough into macaroni in one continuous operation. From the late 1950s, extrusion processes were developed to manufacture products such as dry expanded pet food, dry expanded 'ready to eat' breakfast cereals and textured vegetable protein. Today, a wide variety of intermediate or food products are produced by extrusion. Anonymous (2012) used Single-screw extruders in the 1940s to produce puffed snacks from cereal flours and grits. During transport through the extruder, mechanical energy from the rotation of the screw is converted to heat, raising the temperature of the mixture to over 150^{O}C.

The resulting plasticized mixture is then forced through the die. The sudden reduction in pressure at the die causes moisture to flash off rapidly as steam, puffing the product. Because single-screw extruders have relatively poor mixing ability, they are often used with materials that have been either premixed or preconditioned. *Horse Gram* (*Macrotyloma uniflorum*) is one of the lesser known beans. The whole seeds of horse gram are generally utilized as cattle feed. However, it is consumed as a whole seed, as sprouts, or as whole meal in India, popular especially in southern Indian states. Altan *et al.* (2008) studied twin screw extrusion of barley-grape pomace blends: Extrudate characteristics and determination of optimum processing condition. Grape pomace was mixed thoroughly with barley flour to the ratio of 0, 2, 6, 10, and 12.73 percent (db). Blends were extruded in a 30 mm APV co-rotating twin screw extruder. Response surface methodology using central composite design was to evaluate the effects of independent variables, namely die temperature (140-160°C), screw speed (150-200 rpm) and pomace level (2-10 percent) on product responses functional properties like expansion, bulk density, texture and colour.

He reported that, blends of 2 percent grape pomace extruded at 160°C, 200 rpm and 10 percent grape pomace extruded at 160°C, 150 rpm had higher preference levels for parameters of appearance, colour, texture. Lazou *et al*. (2007) studied the effect of extrusion conditions, including feed rate (2.52–6.84 kg/h), feed moisture content (13–19% w. b.), screw speed (150 – 250 rpm) and extrusion temperature (150–230°C) on structural properties of corn-legume based extrudates. Four different types of legumes namely chickpea, mexican bean, white bean, and lentil were used to form mixtures with corn flour in a ratio ranging from 10 to 90% (corn/legume). Result showed that the influence of feed rate in the extrudates porosity is incorporated into mean residence time. Porosity of extrudates was found to increase with temperature and residence time and to decrease with feed moisture content and corn to legume ratio. Screw speed did not affect extrudates properties. Expansion ratio showed a similar behavior with porosity. The addition of legumes led to more dense products. Comparatively, the usage of white bean in mixtures for the production of snacks, led to a product with higher porosity than those with other legumes.

Plahar *et al*. (2003) standardized extrusion cooking process for developed of a high protein weaning food based on peanuts, maize and soybeans and evaluated the effects of blend formulation, extrusion temperature and feed moisture content on ease of extrusion and product quality characteristics. Results showed bulk density and hardness increased while expansion index decreased with increase in feed moisture content. For ease of extrusion and best product quality in terms of sensory attributes and cooking properties, the extrusion parameters were established for a blend formulation of 75% maize, 10% peanut and 15% soybean: feed particle size of 300–400 μm extruded using a screw speed of 500 rpm, with a feed rate of 4.6 kg/min, feed moisture content of 16–18%, and extrusion temperature of 100^{0}C–105^{0}C. Carvalho and Mitchell (2000) investigated the influence of added sucrose in maize grits and wheat flour on the degree of expansion and extent of starch conversion on extrusion processing. Replacing wheat flour by sucrose even at levels as high as 20 per cent of the flour weight had little effect. Possible causes discussed were less efficient plasticization of wheat flour by sucrose compared with maize grits at low water contents, a specific role for gluten and the larger particle size of maize grits compared with wheat flour.

Faller *et al.* (1999) concluded that moisture content and extrusion conditions as well as soy protein type are directly related to sensory and physical characteristics. Information available to consumers either prior to or at the point of purchase may influence product selection. Iwe (1998) studied the effects of extrusion cooking on functional properties of mixtures of full-fat soy and sweet potato. Full-fat soy and sweet potato were extruded at 0:100, 25:75, 50:50 ,75:25 and 100:0 ratios in single screw extrudate (Insta-Pro 600 Model) operated at a screw speeds of 180, 200 and 220 rpm and barrel temperature of 120 to 140°C and die temperature of 150°C. Functional properties like bulk density, expansion ratio, water absorption and solubility indices and trypsin inhibitor were analyzed. He reported that the addition of soybeans to sweet potatoes considerably increase in the protein, fat, ash and trypsin inhibitor levels of raw material mixtures and decrease in viscosities of raw material mixtures with corresponding increase in pasting temperature .Also, water solubility index at increasing speed.

MATERIALS AND METHODS

The research work on Horsegram based extrudates development was undertaken. to investigate the possibility of making extrudates using Horsegram as base material, experiments were formulated for maize, rice, and horsegram in different proportions. The experimental work was carried out in the Department of Agricultural Process Engineering (APE), College of Agricultural Engineering and Technology (CAET), Dapoli.

Experimental design

In the present investigation maize is used as best supporting starchy material and rice is used as supporting starchy material. Horse gram flour level was increased from 20 to 50 per cent. Maize flour level kept constant as 50 per cent. Rice flour level was varied with horse gram level. Raw materials for the development of horsegram based extrudates used were horsegram, maize, rice, oil and spices. Horsegram is used because of its good storage quality, high nutritive value and therapeutic value, hence used as base material. In the present study the extrusion of horsegram, maize and rice was done at screw speed at 275 rpm, temperature 150 ^{0}C with 3mm die.

Twin screw extruder – Experimental Device

A co-rotating twin screw extruder (M/S. Basic Technology Private Ltd., Kolkata, India) with 3 mm diameter die was used for extrusion of maize, and rice flour with different proportion of horse gram.

Tray dryer

A tray dryer was used for the drying of horsegram based extruded products. The Tray dryer used was made by M/S. Basic Technology Private Ltd., Kolkata, India. The size of the dryer was 900×600×300 mm with one shelve. It contains 6 trays of 30×20 cm in size. The drying was done by forced recirculation of hot air around the extrudates. Texture analyzer The Texture analyzer was used for measurement of hardness of the extrudates. Hardness is the force required to compress a substance between the molar teeth or between tongue and plate to a given deformation or penetration and designate as soft, firm or hard. Texture analyzer of M/s. Brookfield Engineering Labs, Inc., USA. was equipped with a 50 kg load cell and TA3/100 probe operated at a test speed of 1 mm/s transversally to the.

Preparation of extrudates

The composite flour mixed samples were conditioned with 10% (wb) moisture on weight basis by spraying and mixing continuously at medium speed in a blender. The feed material was then allowed to stay for 2h to equilibrate at room temperature prior to extrusion. This preconditioning was employed to ensure uniform mixing and hydration and to minimize variability in the state of feed material. The levels of horse gram varied from 40,30 and 20 percent, keeping Maize constant at 50 percent and rice as supporting as 10 ,20,and 30percent respectively. In extruder cooking of blends took place under controlled condition which cause the change of state *i.e.* from granular state to plasticized dough. When this dough came out through extruder, through die, it suddenly expanded due to sudden release of pressure. After cooling to room temperature, these extrudates were cut into 5-6 cm in length and dried at 60^{0}C for 1 h in tray drier. After cooling, the extrudates were packed in polythene bags at room temperature (25± 2^{0}C) for further quality analysis.

Functional properties of extrudates

The functional properties of extrudates are expansion ratio, bulk density, colour and hardness etc. Expansion ratio and bulk density of extrudates seek to describe the degree of puffing undergone by the dough as it exits the extruder. Colour is an important characteristic of extruded foods which can give information about the extent of browning reaction such as millard reaction, degree of coking and pigment degradation (Altan *et al.,* 2008).The functional properties of extrudate i.e. bulk density, expansion ratio, colour and hardness were calculated as per standard methods.

Colour

A colour co-ordinate of extruded product was measured under colour flex meter. The colour flex meter was manufactured by Hunter associates Laboratory, USA. It represents the colour in L*, a* and b* value. Degree of lightness or darkness of the samples was represented by "L*" value, redness to greenness by "a*" value and yellowness to blueness by "b*" value on hunter scale. The apparatus was previously calibrated with standard white and black tile. Colour (L*, a*, b* values) of the extrudates samples were determined. L* indicates the lightness and extends from 0 (black) to 100 (white). The other two coordinates a* and b* indicates redness (+ a) to greenness (- a) and yellowness (+ b) to blueness (-b), respectively.

Hardness of Extrudates

The peak force as an indication of hardness was measured with Texture Pro CT V1.3 Build Texture Analyzer (Brookfield Engineering Labs, Inc., USA). The test speed was 0.5 mm/s and the distance between two supports was 22 mm.

RESULTS AND DISCUSSION

This chapter contains the result of observations made in the course of investigation. The data obtained from the different experiments have been analyzed and presented in this chapter. The interferences drawn has also been discussed to support the findings with the appropriate references wherever possible.

Functional properties of horsegram flour based extruded product

The functional properties of extrudates are expansion ratio, bulk density, colour and hardness etc. Expansion ratio and bulk density of extrudates seek to describe the degree of puffing undergone by the dough as it exits the extruder. Colour is an important characteristic of extruded foods which can give information about the extent of browning reaction such as millard reaction, degree of coking and pigment degradation. Results related to the functional properties of horsgram based extruded product are given below.

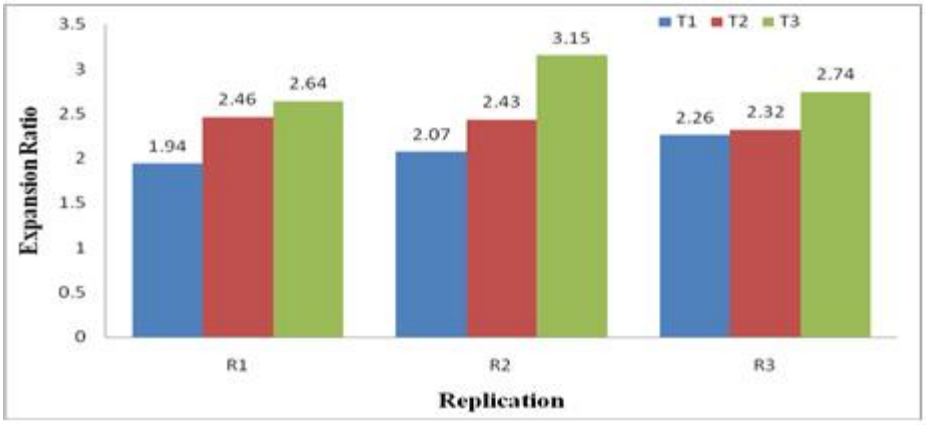

Fig. 1. Expansion Ratio (ER) of extrudates prepared from horse gram based mixed flour

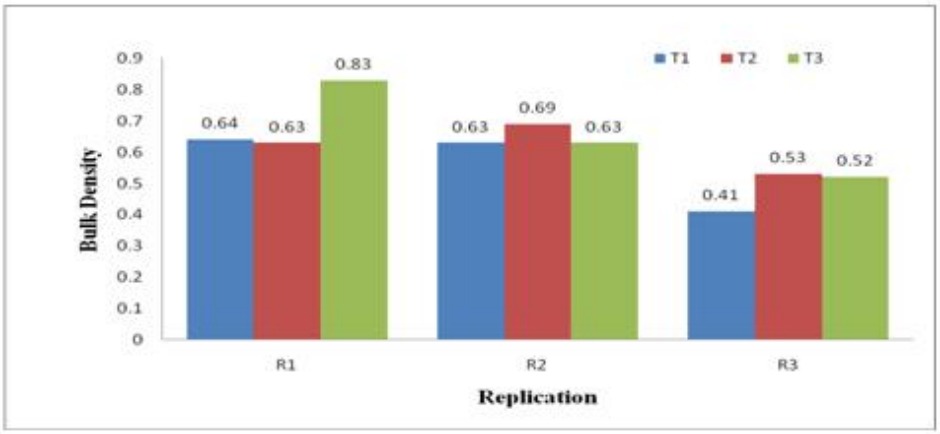

Fig. 2. Bulk Density (BD) of extrudates prepared from horse gram based mixed flour

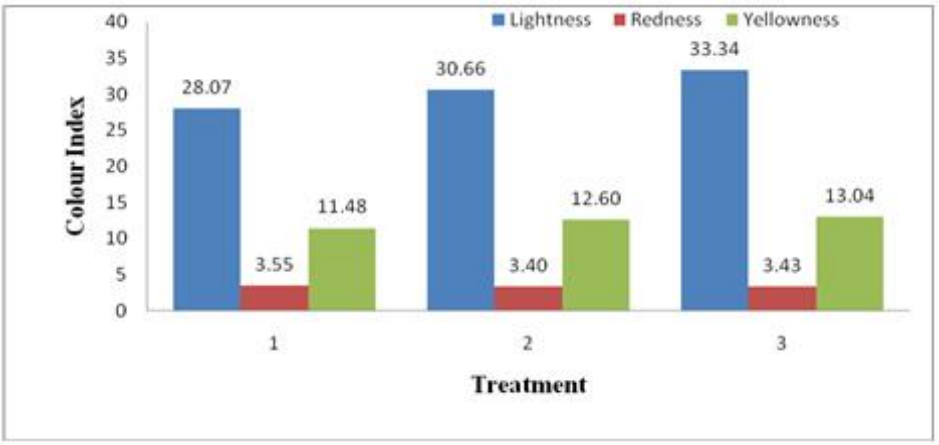

Fig. 3. Colour index of extrudates prepared from horse gram based mixed flour

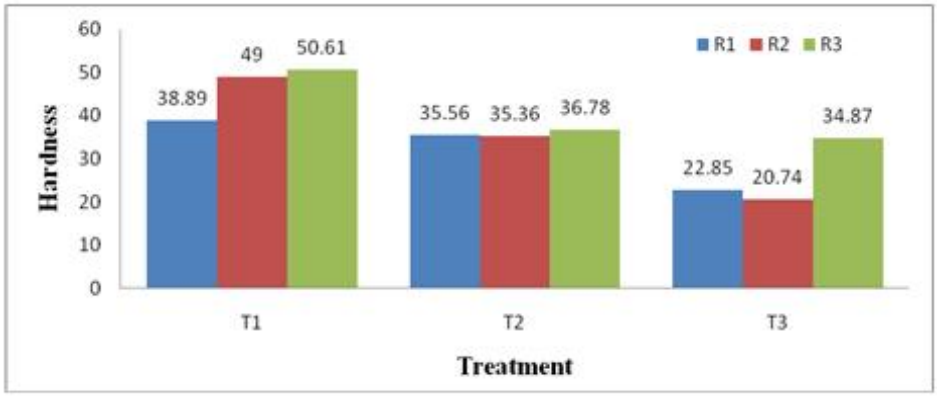

Fig. 4. Hardness of the extrudates prepared from horse gram based mixed flour

Expansion Ratio

Expansion of extrudates of is mainly due to sudden change in state of high pressure to atmospheric pressure. This pressure drop causes a flash-off of internal moisture and water vapour pressure, which is nucleated to form a bubble in molten extrudates, which results in expansion of melt. Bubble growth due to vapour pressure of steam is primary factor that influences expansion in both radial and longitudinal direction. Also the pressure drop at the die is directly responsible for expansion, but it is a cause for bubble nucleation. The measured expansion ratio varied from 1.94 to 2.26 for Treatment 1, it lies between 2.32 to 2.46 for Treatment 2 and 2.64 to 3.15 for Treatment T_3. The trend is given in Fig.1.

Bulk density

Bulk density of extrudates is important parameter in the production of expanded food products and also in relation to their ability to float or sink when poured into water and their packaging requirement. Bulk density, which considers expansion in all directions. Bulk density ranges from0.63 to 0.83 g/cm^3 for Treatment 1, it ranges from 0.63 to 0.69 g/cm^3 for Treatment 2 and for treatment 3 it ranges from 0.41 to 0.53 g/cc in this study for horsegram flour extrudates. Details are given in Fig.2.

Colour

Color is an important quality factor directly related to the acceptability of food products, and is an important physical property to report for extrudate products. Color changes can give information about the extent of browning reactions such as caramelization, Maillard reaction, degree of cooking and pigment degradation that take place during the extrusion process. The lightness (L*) is an indication of the brightness. The lightness value of the horsegram flour based extruded product ranged from 28.07 to 33.34. Fig. 3 shows that increase in lightness with decreasing horsegram level. An increase in expansion gave more bright color in extrudates due to air cells rather than dull color. The color parameter a*, indicative of the redness of sample and in general, the products cooked with high temperature have the highest values. Dark color is also developed during caramelization of sugar. Figure 4.3 shows that effects of extrusion temperature horsegram level on the a* (redness) colour compound for horsegram extruded products. Result shows that there is slight effect on redness of product when horsegram level is changed. Redness of horsegram based extrudates ranges from 3.40 to 3.55. The yellowness value (b*) of extruded products varied from 11.48 to 13.04 for horsegram flour based extruded product. Figure 4.3 shows that the change in yellowness during extrusion cooking was most induced by the effects of non enzymatic browning and pigment destruction reactions. All these differences could have been due to the shear forces generated during extrusion which accelerated the chemical reactions between amino acids and reducing sugars that took place during extrusion and to the different horsegram and rice level conditions during extrusion.

Hardness

The higher the value of maximum peak force required in gram, which means the more force required to breakdown the sample, the higher the hardness of the sample to fracture . The effect of horsegram level on hardness of extrudates is shown in Fig 4. Also Figure shows that increase in level of horsegram increased the product hardness. Hardness of horsegram flour based extruded product varied from 38.89 to 50.61 N for treatment 1, it ranges from 35.36 to 36.78 N for treatment 2 and 20.74 to 34.87 N for treatment 3. Higher density product naturally offers more hardness evident by high correlation between product density and hardness.

Conclusion

It is observed that the good quality extradites can be prepared by using horsegram based composite flour with the help of twin screw extruder at 275 rpm and 150 ^{0}C with 3 mm die. Horsegram was used as base material. Three horsegram flour levels of 40, 30 and 20 per cent were used. The functional properties viz. Expansion Ratio (ER), Bulk Density (BD), colour and hardness of extrudates were determined. The effect of processing parameters on functional properties was also studied.Expansion ratio, bulk density, colour and hardness were influenced by variations in flour composition. It is found that, extrudate made using horsegram, maize: rice: The findings of investigation study demonstrate the feasibility of developing value added products from horsegram based composite flour by extrusion processing. It is concluded from this study that horsegram extrudates of 20 percent horsegram with 50 percent maize, and 30 percent rice showed better functional properties as compared to all other treatments in terms of high expansion ratio and lightness in colour and lower in hardness.

REFERENCES

Altan A., L. Kathryn, McCarthy and M. Medeni. 2008. Twin screw extrusion of barley-grape pomace blends: Extrudate characteristics and determination of optimum processing condition. *Journal of Food Engineering*, 89:24-32.

Camire, M., C. Clykink and R. Bittner. 1991. Characteristics of extruded mixture of corn meal and glandless cottonseed flour. *Cereal chemistry*, 68 (64):419 − 424.

Caravalho.W P and J.R.Mitchell. 2000. Effect of sugar on extrusion of maize grits and wheat flour. *International Journal of Food Science and Technology*, 35:569-576.

Eastman J., Orthoefer, F. and S. Solorio. 2001. Using extrusion to create breakfast cereal products. *Cereal Food World*, 46 (10): 468-470.

Faller J. Y., B. P. Klein and J. F. Faller. 1999. Acceptability of extruded corn snacks as affected by inclusion of soy protein. *Journal of Food Science*, 64(1): 185-188.

Iwe M.O. 1998. Effects of extrusion cooking on functional properties of mixtures of full-fat soy and sweet potato. *Plant Foods for Human Nutrition*, 53: 37-46.

Lazou A.E., P. A. Michailidis, S. Thymi, and. M. K. Krokida. 2007. Structural properties of corn-legume based extrudates as a function of processing conditions and raw material characteristics. *International Journal Food Properties*, 10: 721–738.

Lin Y. H., C. S. Yeh and S. Lu. 2003. Extrusion processing of rice based breakfast cereals enhanced with tocopherol from Chinese medical plant. *Cereal chemistry*, 80(4): 491-494.

Magali L., S. F. Taila and M. M. Martha. 2009. Physical characteristics of extruded cassava starch. *Science Agriculture,* 66 (4):486-493.

Plahar W. A., B. O. Okezie and C. K. Gyato. 2003. Development of a high protein weaning food by extrusion cooking using peanuts, maize and soybeans. Plant Foods for Human Nutrition. 58(3): 1-12.

Plahar W. A., B. O. Okezie and C. K. Gyato. 2003. Development of a high protein weaning food by extrusion cooking using peanuts, maize and soybeans. *Plant Foods for Human Nutrition*, 58(3): 1-12.

Santosa B. A., S. Sudaryano and S. Widowati. 2008. Characteristics of extrudate from four varieties of corn with aquadest addition. *Indonesian journal of Agriculture*, 1(2):85-94.

Zhou Z., K. Robards, S. Helliwell and C. Blanchard. 2002. Composition and functional properties of rice. *International Journal of Food Science and Technology*, 37: 849–868.

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